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Methods for Calculating Cartel Damages: A Survey

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The paper focuses on the various methods used to quantify cartel damages, which have become more and more important as private damage suits in the aftermath of antitrust litigation increase. The approaches implementation is embedded into current legal environments with regards to the estimation approaches being used for quantification of cartel damages. The direct comparison of methods shows that difference methods convince due to their simplicity and plausibility in results as well as replicability. Cost-based approaches have to overcome hurdles but still are easy to conduct and comparatively more accurate. In contrast, price prediction takes market changes into account and the market simulation presents the most sophisticated and flexible approach, provided that assumptions are correct and correctly implemented, and therefore approaches the "real world" counterfactual as approximate as possible.

Key words: Cartels, damages, antitrust policy, public enforcement, private enforcement

JEL: C10, C15, L12, L13, L4, K21, K41

1. Introduction

One of the most important tools a competition authority has at its disposal in order to protect competition and deter from future antitrust infringements is to impose cartel fines as a consequence of anticompetitive behavior of market players. The European Commission imposed approximately 5.4 billion Euros of fines within 16 cartel procedures, in which 120 companies were involved during the last three years.[2]

Attached procedures of antitrust litigations, such as private damage claims, whose enforceability is more and more favored by western antitrust regimes, and the passing-on effect, namely the price increases for indirect buyers of cartelized goods, whose defense has been rendered possible e.g. in the European Union and Germany in 2008 respectively 2011, are increasingly relevant, next to cartel punishments of antitrust authorities themselves.

In order to determine the actual size of the cartel overcharge, the difference from the price that would have emerged under competitive conditions and the cartel price, various quantification methods can be employed. In comparison to the determination of fines through antitrust authorities, which normally solely use a defined percentage or benchmark, such as the turnover of the cartel members in the European Union, or the minimum of 100 million Dollars in the United States, finding out about the hypothetical but-for price is a far more elaborate procedure.

The application of existing quantification methods depends on the availability of information, on the one hand, and the envisaged precision of the results, on the other hand.

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[2] See European Commission (2013b).

Before and after and yardstick approaches as well as difference-in-differences tests are comparatively modest in their information requirement, but no market changes are considered within the investigation period. Cost based quantification methods entail the distinction between economic and accounting costs, imply a static view and perfect competition, but generate adequate results in cases where only very few data are available. Price prediction stands out due to its non-static view and the possibility of taking oligopolistic behavior into account. Nevertheless, the same cartel overcharge is assumed for every year under consideration and misspecifications are possible that could decisively influence estimation results. Damage quantification based on simulation methods might be closest to real-world competitive market outcomes, as they do not rely on cost data provided by accused parties and are very transparent for outsiders. At the same time, they present the largest challenges for economists with regard to market comprehension requirements.

Estimating cartel overcharges will thus get more and more complex, if dynamic effects are taken into account (e.g. if competition would induce significant changes in quantity or innovation, market entries occur, etc.). Defining the exact cartel period, as the fundamental prerequisite for damage calculation, might already present an insurmountable obstacle. Price patterns might not be that obvious[3] as e.g. cartels do need some time to form, or episodes of cheating that disturb the price pattern, or temporary reversions to competitive prices occur. The closer the quantification of the actual damage induced by cartels gets to reality (drawing on different market types, such as oligopolistic ones, or types of competition, Bertrand vs. Cournot), the more complex this task becomes.

This paper's analysis focuses on dealings with anticompetitive behavior in Europe and on some German variations, even though a few particulars of the United States (hereafter: U.S.) law are mentioned. The paper is structured as follows: chapter two gives an overview of different types of cartels, the three cartel effects, shows how the relevant antitrust regimes impose fines on cartel infringements, and gives an overview of private damage claims. Chapter three describes the established methods on quantification of cartel overcharges and details each approach's advantages and disadvantages. The chapter four concludes the findings.

2. (On the Economics of) Cartel Damages and Sanctions

2.1 Cartels – An Overview

Article 101 TFEU prohibits agreements between related companies that aim at the prevention, restriction or distortion of competition within the European Union (hereafter: EU).[4] Collusive agreements of companies that regularly lead to price increases thus present antitrust infringements.

[3] This means that prices do not always obviously increase at the beginning of collusive agreements and do not necessarily automatically decrease after the cartel's revelation (downward open U-shape of price patterns).

[4] See European Union (2008).

First of all, one should pay attention to the distinction between tacit and explicit collusion. Tacit collusion is not forbidden under contemporary antitrust law, as firms do not commit to illegal behavior by explicit coordination, even though this behavior might have anticompetitive effects if the market reaches a collusive equilibrium. Implicit collusion depicts the state, in which companies coordinate their behavior without explicitly communicating with each other. Only explicit agreements within cartels cross the line of anti-competitiveness. Explicit collusion, meaning that companies explicitly coordinate determined actions to achieve a collusive result, is juridically considered as illegal behavior.

Companies that decide to build a cartel or to join an already existing one always pursue a target, most of the times to enhance profits to supracompetitive levels, regardless of whether the collusion takes place between horizontally or vertically related companies. There are three main objectives collusive agreements focus on – prices and/or quantities and/or regions – and thus the following categories of prohibited cartels, so-called hardcore cartels, can be derived:

1. Price cartels are collusive agreements between related companies, in which they agree upon prices for the cartelized product. The prices are set higher than some competitive benchmark and/or are close to monopoly prices.[5] Negotiations regularly focus on fixed or minimum prices. Special types of price cartels are the so-called submission cartels. These aim at organizing the cartel members' behavior in public procurement procedures. Mutual underbidding should be avoided, so that every cartel member can count on the acceptance of its assigned tender. The particular tenders, the chronology of winning members, as well as the minimum quotations are determined beforehand.
2. Quota cartels are a type of allocation cartels. The companies concerned allocate production volumes or sales quantities in proportion to each company's own capacities in order to agree upon quantitative offers. Determining prices is also easily achievable within such agreements.
3. Market sharing agreements are an alternative to achieve the same collusive result as price or quota cartels. Market sharing means that some or all firms in a particular market divide it between each other. Each cartel member only sells its products in its designated area afterwards. By means of this cartel agreement, the cartelists are able to set each possible price, as they can be sure about the other cartelists not undercutting it.[6]

2.2 Three cartel effects and further affected areas

There are three potential effects, which could possibly be induced by a cartel. The first one is the direct cartel effect. As normally supposed, cartels are actually formed in order to establish higher market prices compared to the price that would have arisen under competitive market conditions. If the cartelized product is an intermediate production good, e.g. the direct buyer purchases this good as an input factor for its end product, which the direct buyer finally sells to the indirect buyer/end customer, the direct cartel effect will be reflected by an increase of the direct purchasers' variable costs.

[5] See e.g. Motta (2004). p. 138.
[6] See e.g. Irish Competition Authority (1999).

Within such a value-added chain, a cartel induced price increase also results in an increase of the indirect purchasers' costs. Due to the fact that the intermediate good has undergone a price increase, the direct buyer will automatically have a significant incentive to pass on part or all of the price increase to its customer. This effect is called passing-on effect and depicts the difference between the final price increase that end customers face and a hypothetical competitive counterfactual.

The third and last direct price effect of collusion is the output effect. A price increase of the cartelized product normally has a negative effect on the quantity of sales. Higher prices result in lower demand. This effect thus results from smaller sales quantities of cartelists as reaction to the price increase.[7] This effect may even outweigh the enhancing effect of per unit revenue itself induced by the respective collusive agreement, especially if the direct buyer in the downstream market is a monopsonist or has particular buyer power.[8]

Cartels might have an impact on players on the same market that are no cartel members, the cartel outsiders. By having a softening effect on competition due to agreed upon prices or reduced quantity, cartel outsiders can benefit from the very same facts, and thus can also more easily enforce higher prices or decreased quantity than without the cartel. This is called the umbrella effect.[9]

The indirect effects of cartels, such as the umbrella effect, as well as quantity effects of anticompetitive behavior will not be addressed in the following chapters. Direct price effects on intermediate or end customers that are vertically related to the anticompetitive infringement are the field of examination.

2.3 Proceedings of Competition Authorities

After a cartel's detection, the responsible competition authority has to define the sanctions for the cartelists. These regularly depend on the duration of illegal behavior, the respective legal environment, and the cartel's organizational characteristics. There is a current discussion on whether more economic approaches and sanction calculation methods should be taken into account within this antitrust dimension. Traditional measures for the assessment of harm for the direct buyers regularly underestimate their monetary harm, especially when the cartelized product constitutes an input product and the downstream market is not perfectly competitive.[10]

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7 See e.g. Verboven and Dijk (2009).

8 See Hellwig (2007), p. 124 et seqq.

9 See e.g. Friederiszick and Röller (2010), p. 10, or Inderst et al. (2013b), where the latter paper particularly examines umbrella effects that redirect demand to substitute products.

10 See Basso and Ross (2010).

In most of the cases, a cartel member itself reveals anticompetitive behavior.[11] It thereby makes use of the (in most western countries) established leniency program, which guarantees the whispering cartelist reduced or no fines within fine proceedings.[12] After a cartel has been detected, the responsible competition authority will undertake an investigation concerning the cartelized companies and will finally impose fines on them.

The enacted guidelines on the setting of fines within the European Union (hereafter: EU) and its member states were published in 2006. These guidelines determine how the concerned competition authorities should calculate cartel fines. The procedure can be outlined as follows: First, a basic amount for each undertaking or association will be determined. Second, this basic amount will be adjusted upwards or downwards.

In the EU, the basic amount is composed of various sales benchmarks and depends "on the degree of gravity of the infringement, multiplied by the number of years of infringement."[13] The maximum value of sales serving as the basis for the fine calculation is capped at 30%. For determining the specific percentage, market factors such as the nature of antitrust behavior, market shares, and the geographic scope of the infringement are also taken into account. Adjusting factors of this specific basic amount are:

- Aggravating circumstances: repeated or not omitted infringement (up to additional 100% of the basic amount), refusal to cooperate, and a role of leader within or instigator of the anticompetitive infringement.
- Mitigating circumstances: rapid termination of legal offence after detection, evidence for negligence in cartel participation, considerably limited involvement in infringement, effective cooperation with competition institutions, anticompetitive behavior encouraged by antitrust institution or by legislation.
- Specific increases of the basic amount in order to implement a deterrent mechanism.

The legal maximum cap of the European corporate cartel fine is at 10% of the undertakings' or association's total turnover in the business year the proceedings take place.[14] Under specific circumstances, the competition institution may take a company's financial situation into account. For example, if a firm made an application with regards to its inability to pay the envisaged fine.[15] This exception's importance increased during the current financial crisis.[16]

The Sherman Act presents the competition law counterpart in the U.S., even though not being as clearly structured and interpreted by reference to guidelines as the ones within the EU. The U.S. law also includes the possibility of inflicting imprisonment penalties up to ten

[11] See e.g. Friederiszick and Maier-Rigaud (2007), p. 178 et seqq.

[12] See homepage of the German competition authority "Bundeskartellamt": http://www.bundeskartellamt.de/wEnglisch/Kartellverbot_e/kartellverbot_eW3DnavidW2629.php.

[13] European Union (2006), Section 1, Point 19.

[14] The 10%-constraint can lead to ambiguous results in case of a one-product-firm and is broadly discussed in scientific literature. See e.g. Soyez (2013), p. 103.

[15] See European Union (2006).

[16] The EC received nine inability-to-pay applications during 2008 and 2009. This number increased up to 32 (out of 69, thus approximately 46%) in 2010. See Almunia (2011).

years on private persons that have played a decisive role within the anticompetitive infringement.[17] While other countries also have this kind of penalty at their disposal[18], this possibility does not exist in the European Commission (hereafter: EC) law and in Germany, even though there are some calls for this penalty[19].

The following chart gives an overview of enacted antirust handlings of the aforementioned competition authorities:

Country /Region	Cartel fines		Damage compensation	
	Reference point	Maximum fine	Legal reference point	Passing-on defense
Germany[20]	Turnover (up to 30% of the turnover achieved during and from the infringement)	Companies 10% of the turnover achieved in the previous business year or of the turnover achieved from the infringement. Multiplication factor that accounts for the size of the company. Private individual Up to € 1 m.	Whoever intentionally or negligently commits an infringement against Articles 101, 102 TFEU	Permitted Introduced after ORWi-jurisdiction (June 2011)
EU[21]	Value of sales (up to 30% of the value of sales)	Companies 10 % of the total turnover in the preceding business year	"Everyone who has suffered harm because of an infringement of Article 101 or 102 TFEU has a right to be compensated for that harm."[22]	Permitted Introduced in the course of EC's White Book publication (April 2008)
U.S.[23]	Highest value of: 1. Point system (based on offense level and criminal history determination) 2. Pecuniary gain 3. Pecuniary loss	Companies Highest value of: 1. U.S. $ 100 m 2. Twice the gross gain 3. Twice the gross loss Private Individual Highest value of: 1. U.S. $ 1 m 2. Twice the gross gain 3. Twice the gross loss 4. Imprisonment not exceeding 10 years		Prohibited Under Federal Law Illinois Brick Doctrine Possible under State Law

2.4 Private Damage Claims

A further clear distinction must be drawn between the fines assessed and imposed by a competition authority in the course of an antitrust procedure and the actual damage a cartel

[17] Antitrust Criminal Penalty Enhancement and Reform Act of 2004, Pub. L. 108-237 § 215(a), 118 Stat. 668 (2004).
[18] Up to day: Australia, Brazil, Canada, Iceland, Indonesia, Israel, Japan, Korea, Norway, Russia, Thailand, and Zambia, see Shaffer and Nesbitt (2011), p. 8.
[19] See e.g. Wagner-von Papp (2010).
[20] See Bundeskartellamt (2006), GWB (2012), BGH (2011), and Bundeskartellamt (2013).
[21] See European Union (2006), European Commission (2008).
[22] European Union (2011), Part 1, I, A, 1.
[23] See United States Sentencing Commission (2012), and USC (2012).

has inflicted on its (direct and indirect) customers. The latter can actually exceed, and regularly do exceed in Europe, the former to a large extent.

The fines a competition authority imposes on cartel members, after having been informed or found out about the infringement in the first place, are based on the focal points presented in the table above. In the EU, whereupon this paper mainly focuses, thus the turnover.

The EC has pushed the enforceability of private damage claims within cartel procedures vehemently in recent years. Within its White Paper on Damages actions for breach of the EC antitrust rules[24] from 2008, the EC states that every victim of anticompetitive behavior has to have the possibility to claim reparation from the responsible companies. In practice, there are still numerous legal uncertainties that must be overcome in order to increase the number of private damage claims. The EC just recently proposed legislation that aims at facilitating private damage claims, in which it also focuses on damage quantification in order to give guidance to courts and affected parties.[25]

The amount of damage a claimant can sue for can be calculated in different ways.[26] What should be emphasized at this point is that the damage might have occurred on the direct buyer's side and on the indirect buyer's side.[27] The indirect customer of a cartelized good, who bought the very same thing from the direct cartel's customer at increased prices, might (depending on the respective legal jurisdiction) also have the right to demand for its damages.[28] When cartelized companies try to lessen their own cartel damage in court with the aforementioned price increase distributions, this is called the passing-on defense.

The European Court of Justice strengthened the passing-on effect within the EU in its Manfredi judgment by stating that any individual has to have the possibility to claim damages before national courts; thus also indirect customers.[29] The ORWI judgment of the Federal Court of Justice can be seen as a landmark decision in Germany.[30] The Court therein states that indirect buyers can also claim compensation, and that this might even be advantageous for the cartelists themselves (as they can allege the passing-on defense against direct claimants), as long as this does not finally result in not having to pay any compensation at all or too little. The burden of proof lies with the cartel members.[31] Nevertheless, private damage claims, no matter if instituted by direct or indirect customers, are quiet troublesome, which is due to its very nature.

Deterrence is the overall objective of the world's antitrust regimes.[32] The threat to have to pay substantial compensation for violations of antitrust rules, either to the particular competition authority or the private aggrieved parties, might already discourage the respective

[24] See European Commission (2008).
[25] See European Commission (2013a).
[26] The next chapter of this paper takes a closer look at quantification methods for the „real value".
[27] As already mentioned in section: 2.2 Three cartel effects.
[28] In this case the direct customer either suffers only part of the whole cartel damage or no damage at all. The latter case will only occur under very specific demand conditions in the downstream market. For further information, see e.g. Davis and Garcés (2011), p. 368 et seqq.
[29] See European Court of Justice (2006), Point 61.
[30] See BGH (2011).
[31] See Kirchhoff (2012), p. 927 et seqq.
[32] See amongst others Connor (2009).

companies from cartelization.[33] The deterrence effect of private damage claims is one reason, amongst others, why the EC is so heavily trying to advance private damage claims in cartel cases. An increase of this number would also lead to additional deterrence effects for future (potential) infringements. Private claimants constitute private supplements to public cartel law infringements within this context.[34]

3. Methods of Quantifying Cartel Damages

3.1 Literature on quantification approaches

As damage quantification executions are conducted more and more frequently, scientific and economic literature with focus on the different approaches has accumulated within the last years. Several studies present quantification methods in a manner similar to the analysis presented in this paper.

Ashurst (2004) were the first one to compile a cartel damage quantification study for the EC, which gives a very structured overview of the court decisions at the time of examination. Oxera (2009) also prepared a damage quantification study on behalf of the EC aiming at shedding some light on this untransparent area from both legal and economic perspectives. The study differentiates between comparator-based, financial-analysis-based, and market-structure-based approaches, describes the counterfactual foundation of each approach, and categorizes the available techniques. Even though giving a sound and broad overview of the field of quantification approaches and adding various practical examples from cartel cases throughout the EU, both studies do not go into econometric detail.

Connor (2009) examines the antitrust litigation of the lysine cartel rather intensively and points to quantification problems as he emphasizes that the before and after method is rather critical in cases in which cartel formation took place after a recession (which appears to be a frequent situation) and under such circumstances the benchmark might be understated and damages overstated, et vice versa. Connor (2001) is a kind of predecessor to the aforementioned article.

Dijk and Verboven (2008) also distinguish between damage quantification methods that use comparator indicators and methods that are based on direct information about the cartelized market. They also introduce critical loss analysis as one approach belonging to the latter category. By determining the break-even point at which demand decreases given a particular price increase and comparing this to the expected actual loss, cartel price overcharges can be calculated.

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[33] The deterring effect of cartel fines is a wide-raging scientific study area. Various studies come to the conclusion that the deterring effects of corporate penalties indeed have been sub-optimal during the last years, and that competition authorities have to employ detection in addition to deterrence mechanisms. See e.g. Connor (2009) or Hüschelrath and Weigand (2010).

[34] Private litigation might also be regarded as a process generating extra costs, next to the already effective public enforcement, and thus duplicate enforcement efforts. See e.g. Hüschelrath and Peyer (2013).

Davis and Garcés (2010) study the very same approaches (partially with different naming) from a straight practical, partially econometrics-based perspective. They give numerous examples and graphics arising from practical court proceedings for which cartel damages have been calculated. They furthermore explain the approaches' basic idea and effects by indicative formulas. Friederiszick and Röller (2010) also briefly broach the subject of quantification methods. Their examination is based on data and experiences from the German cement cartel case. They demonstrate the general trade-off between accuracy and practicability in cartel cases (see: 3.3 Accuracy vs. practicability). Fumagalli et al. (2010) screen quantification methods on cases of infringement of Article 102 TFEU and thus deal with abuse of a market dominant position. They point to the differences that arise from foreclosure rather than from collusion, which are mainly due to the fact that foreclosure may indeed affect both customers and competitors in contrast to cartels which mainly affect customers on different value-added steps.

Kneuper and Langenfeld (2011) primarily contrast the approach of the U.S. Sentencing Guidelines with the determination of volume of commerce affected in cartel procedures (thus the damage caused by the anticompetitive infringement), and derive their advantages and disadvantages. When presenting different economic quantification methods they also introduce natural experiments as an approach to determine or verify the but-for market outcomes, and depict advancement in the difference methods by customer differentiation (groups of customers or even individual ones).

Inderst et al. (2013a) firstly examine, which kind of damages can be caused by a cartel and in which direction on the upstream as well as downstream level they have an impact. They also focus on harm resulting from abusive behavior of a firm holding a dominant position and further aspects of damage estimation, such as the discounting of damages and after-effects.

The paper at hand pursues an all-inclusive aim by addressing both public and private antitrust enforcement. By focusing on the latter it presents cartel damage quantification methods and the research on this topic in its contemporary entirety.

3.2 Damage Quantification with Empirical Methods

Collusive behavior, irrelevant whether price- or quota-fixing cartels as well as market sharing agreements, regularly increases price levels though the magnitude of effects differs. Empirical examinations in the scientific literature try to assess the average price increases of cartels. Connor and Bolotova (2006) for example take more than 800 cartels during the last 125 years as the basis for their empirical estimation. They come to the conclusion that the mean value of cartel overcharge equals to 29%, and the median equals to 18%.[35] Lande and Connor (2008) estimate an average cartel price increase of 31% to 49%, and a median overcharge within the range of 22% to 25% in a subsequent survey.

[35] Other empirical papers come to far higher overcharge estimation results. E.g. Connor and Lande (2006): The overcharge of European cartels ranges between 28 % and 54 %. Whereas country-

For quantifying the actual damage for the cartel's purchaser(s), there are different approaches that are discussed within academic studies (see section above), as well as practically applied in damage suits.[36] The following analysis will demonstrate the most common techniques, and will discuss each one's advantages and disadvantages. Each of these approaches aims at revealing the price that would have emerged under competitive conditions, the so-called counterfactual but-for the anticompetitive infringement. All of them are based on some economic models derived from the specific cartel case, even though to varying degrees. Difference methods are indeed of highest importance in damage quantification.

The damage estimated by means of these approaches would always be a lower bound of the true harm caused, as reduced quantities and the resulting deadweight loss are not taken into account.[37] Potential dynamic effects of anticompetitive behavior, such as less innovation and reduced R&D dynamics and a consequent loss of diversity and product quality, as well as market foreclosure, might only be speculatively measured and therefore primarily incorporated as expectations.

The following analysis of cartel damage quantification measures is structured in a twofold way: First, basic information regarding each approach's attempt will be presented. Second, each quantification measure is examined with regards to different criteria. From a content-related viewpoint, the four analysis criteria are focusing on the following dimensions:

- data requirements: This analytical dimension is decisive for the implementation of each quantification method. Degrees and extent of required company or market data varies heavily from method to method. If necessary data are not available, the envisaged approach is not practicable. The criterion of data requirement also encompasses the aspect of time for data assembly and thus includes a cost factor for quantification execution. It serves as the basis criterion for each further content-related examination.
- adequateness of prediction: When deciding about the level of detail for overcharge quantification, it can be helpful to first get an idea about the damage extent rather than directly estimating the counterfactual but-for the infringement as elaborately and realistically as possible. Some quantification methods demand less data and do not take specific market circumstances into account. Some estimate the competitive counterfactual by either drawing on large databases and/or developing sophisticated competitive market models. Adequateness of prediction is lower for the first ones and higher for the latter ones. This criterion is thus about the quality of damage prediction that is highly case-dependent.
- restrictions and difficulties: This examination dimension focusses on limitations of each estimation method's implementation that either derive from its practical execution or from scientific research. Limitations can occur due to restrictive underlying assumptions or they e.g. depict constraints for economists as they are not practicable to implement market specific characteristic, which would have been fundamental to adequately model this market.

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specific cartels exhibited lower overcharges which range between 16 % and 48 %. Still, criticism on all of these results was offered.

[36] Prior to the Guidelines on the method of setting fines, the estimation of cartel fines by European competition authorities has also been based on these approaches (see: European Union (2006), as already mentioned above.

[37] For literature analyzing the problem of deadweight loss resulting from cartel infringements, see e.g. Davis and Garcés (2010).

- extensions: Extensions of the various quantification approaches, examined in the following, have been developed from scientific researchers and/or practitioners. They regularly present an advancement of the initial version with regards to implementation, in a practical sense, e.g. combination of quantification or econometric methods, or with regards to the counterfactual result's adequateness of prediction.

The second analysis dimension focusses on application-related criteria, which are:

- practicability aspects: This analysis focusses on the practical implementation of each quantification method for economists in terms of e.g. time effort, training requirements, and econometric understanding.
- transparency for non-economists: As it is mentioned in the majority of the cartel damage quantification literature, it is of particular importance that but-for results are tangible and understandable for non-economists. Courts, lawyers, and procedure parties that are non-economists are regularly the target group for which damage quantification has been prepared. They thus have to be able to understand the quantification results as well as the economic path towards them. Transparency varies from method to method and can respectively has to be increased by either graphically illustrating them or explaining the underlying mathematics in great detail.
- importance in executed antitrust litigations: This criterion stands for each approach's application in (major) antitrust court procedures, in the past. It shows the importance in real-world damage calculation, not only in theory.

The importance of compliance regarding the different criteria differs from approach to approach and is highly case dependent. This will be emphasized within each examination. When analyzing the different methods, it should be recalled that each one's ability to adequately measure the cartel induced price increase is highly dependent upon how precisely and reliably it can separate between collusive effects, on the one hand, and from other, exogenous effects that are not related to the anticompetitive conduct, on the other hand.

3.2.1 Before and After Approaches

Basic Information

The principal approach when calculating the damages induced by a specific cartel is the difference method. The before and after approaches are time series based approaches that simply compare prices from different periods before, after, and during the cartel. This approach is one variant of difference methods. Its result then depicts the case specific cartel overcharge. The focus is on differences in prices within determined time horizons in order to find out about the hypothetical counterfactual. Following temporal horizons are possible:

- Before and during: When applying these time horizons, the approach compares the prices of the temporarily cartelized product before the beginning of the effective collusive agreements with prices that were set during the cartel period.
- During and after: The second period under consideration defines the timeframe relevant for benchmarking as during and after the cartel period.
- Before, during, and after: This third time horizon compares the prices of the relevant product before, during, and after the cartelized period.[38]

[38] For this definition of possible temporal horizons, see Oxera (2009), p. V.

The estimated differences between the determined temporal horizons thus represent the result of the damage quantification; the cartel overcharge. This is the price increase due to the anticompetitive infringement in comparison to the hypothetical price under competitive conditions.[39] The assumption taken as a basis in these quantification approaches is that the benchmark periods represent reasonable prices that would have emerged under perfect competition.

Content Analysis

From a content specific point of view this approach indeed presents the simplest of all methods analyzed within this paper. Only few data are basically necessary in order to achieve a result. Gathering determined time horizons as benchmark periods with regard to the price but-for the infringement is an adequate way in cartel cases that are timely definite and that have not lasted long. Also, significant market changes[40] should not have been taken place within this demarcation horizon. Transforming the before and after approach into a simple regression framework with a dummy variable can substantiate the quantification results, especially with regard to taking external influence factors into account (see section 3.2.4 Price Prediction).

When applying time-based comparisons, some principal prerequisites exist that are sometimes hard to fulfill: The beginning of the cartel might be hard to define (especially in cases in which the prices do not directly increase to a substantial degree). The end of a cartel as well as the time before might be characterized by intensive competition between the market players or recessionary periods, which in turn would lead to higher overcharge calculations as their basis is not a sustainable price[41].[42] Market prices, which are cartel-biased or not collusion-free, might be gathered rather than actual comparable ones. Nevertheless, it is regularly less difficult to identify when the cartel ended than when it started, especially in cases where it had been detected by a competition authority or revealed by a crown witness. But a cartel break-down might in turn only last for a short period and restart its anticompetitive behavior at a later date either explicitly or tacitly.[43] The main problem of establishing the exact cartel period may be overcome with an extension of the approach which lies in a statistical determination of the beginning and the end of the cartel period with an exogenous structural break analysis.[44]

The requirements listed above also reveal the difficulties and constraints of the method. Market prices are always influenced by various market characteristics. Small changes in demand, capacity or the number of market players can already lead to significant changes in price. It is thus very important for an adequate benchmark price, when applying the before

[39] See Davis and Garcés (2010), p. 354 et seqq.

[40] Changes in market characteristics such as: Demand growth, capacity changes, market entries, etc.

[41] Sustainable prices are a prerequisite to comparative methods. The Federal Court of Justice (of Germany) explains in its ORWI-judgment that appropriate comparative prices are those that arise from functioning markets that yield prices, which reflect a market-compliant interaction of supply and demand. See Bundesgerichtshof (2007). From an economic point of view, this corresponds to a price that is higher than the company's marginal costs and thus (partially) covers fixed costs.

[42] See Inderst et al. (2013a), p. 24 et seq., and Connor (2009), p. 313.

[43] See Nieberding (2006), p. 370, and Kneuper and Langenfeld (2011).

[44] See Dijk and Verboven (2008), p. 2337.

and after method, that few or no market changes occurred within the defined timely horizons. When changes in important market features eventuated, it is necessary that these also play a role during the cartel period in order to have the same market environment. Otherwise one would compare apples and oranges and the but-for price would be misleading.

Further limitations of this approach are that the prices during the cartel period are assumed to be constant and stable, but price influencing changes always occur (even in the most stable or traditional markets) and influence even the cartel price level (especially in long-lasting collusive agreements), and that every purchaser of the cartelized good pays the same price. No differences in customers, the resulting differences in bargaining power, and the consequent differences in prices between individual customer groups are taken into account. This kind of difference method solely considers average price levels.[45]

Application Analysis
The before and after method, is very simple in application, assumed that at least some data in the determined time horizons are available. Results from this approach illustrated in a graphical way are especially transparent for every addressee, which is particularly important for courts and lawyers in damage suits. Before and after methods are frequently used in cartel law proceedings due to the methods' practicability. This has been the case within the prominent lawsuits of the uranium cartel[46] as well as the lysine cartel[47] and the paper wholesaler cartel in Germany.[48]

Summing up and from an economist point of view, the before and after approach should basically be considered as simple check tests in order to find out about the approximate extent of cartel damage. It may provide a sufficiently sound proximity in cartel cases that are stable. More sophisticated methods should be used to gather precise damage information.

3.2.2 Yardstick Approaches

Basic Information
The second difference method, the yardstick approach, aims at quantifying the cartel damage by comparing collusive prices with prices that in fact exist in other competitive markets. It is thus also based on the difference method but includes a regional background. The

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[45] See e.g. Ashurst (2004). p. 17 et seqq.

[46] Uranium cartel: The uranium cartel has been built by the five major uranium producing nations (governments and companies) of the world, namely Canada, Australia, France, England, and South Africa within the 1970's. It is interestingly very hard for a researcher to find out about deep details of the case.

[47] The lysine cartel has been organized by five companies on an international basis and took place in the mid 1990's. The U.S. company Archer Daniels Midland (ADM) as well as two Japanese and Korean companies raised the price of the animal feed additive lysine. The cartel was organized by means of at least 25 multiparty price-fixing meetings. It ended with an FBI raid in June 1995. The EC imposed fines on the cartel members that amount to € 109.9 million in June 2000. The overall monetary penalties for the cartelists total € 305 million. See: http://europa.eu/rapid/press-release_IP-00-589_en.htm?locale=FR, or Connor (2009).

[48] See e.g. Davis and Garcés (2010) for the illustration within the uranium cartel procedure, and Connor (2009) with regard to the lysine cartel.

benchmark market should be one with a comparable market situation (with regard to demand, cost structures, etc.), but obviously without collusive agreements. As a general rule, the following product-regions-combinations are plausible for the yardstick approach:

- Comparison of the same product in different geographical regions: Prices of the same product within clearly separate regional markets in different geographical areas are contrasted. This is the yardstick approach typically applied
- Comparison of different product markets in the same geographical region: This benchmark market should be used in order to find out about specific product characteristics within identical regional conditions.
- Comparison of different products in different geographical regions: In case (cartel-free) comparison elements are neither available for the product of focus nor the geographical market, one could draw on substitutive products within a comparable but geographically different market.[49]

Yardstick comparisons are primarily used for quantifying the damage of a cartelized product in connection with the same product in competitive benchmark markets that are certainly not infected by such an infringement and that exhibit similar market characteristics. Within such a constellation this approach is quite a simple and helpful tool.

Content Analysis
Data requirements are limited in order to conduct such method and, given the benchmark product and/or market is indeed highly comparable with regard to its main characteristics, the implementation is comparatively easy and can be carried out quickly. Results can illustrate the market results of industries in other countries, of different demand models or divergent market shares. They can furthermore estimate bidding outcomes in markets that are not cartel inflicted.

The yardstick approach includes limitations analogue to the constraints of the first difference method; the before and after approach. The differences, standing for the induced cartel damage or overcharge, estimated by yardstick methods are easily prone to error. A control for differences that are naturally inherent in different geographical markets or products is necessary. Similar technologies, cost structures and demand conditions are needed. Especially in comparison cases of international markets, influence factors such as effects of exchange rates on cost, prices, and profits limit these approaches applicability.[50] Furthermore, it can never be guaranteed that the benchmark is indeed cartel-free or cartel-unbiased. Therefore, indirect cartel effects also need to be eliminated. As an appropriate yardstick product is highly likely to be a substitute for the cartelized product, it might be an insurmountable task to find a benchmark product that is unaffected by the anticompetitive agreement.[51]

Further explainable factors that possibly influence price changes on the cartelized market can be corrected for by transforming the yardstick approach into a multivariate regression, comparable to the extension of the before and after method[52] (see 3.2.4 Price Prediction).

[49] For this differentiation, see Ashurst (2004), p. 19.
[50] See Ashurst (2004), p. 19.
[51] See Connor (2009), p. 322.
[52] The main difference to the above mentioned regression is that the dummy variable identifies the cartelized market rather than the timeframe of the cartel.

The assumption underlying this approach is that all differences in prices, which cannot be explained by exogenous influence factors, can directly be traced back to the anticompetitive behavior and thus present the overcharge.[53] This might still be very assumption-based but with a higher explanatory power.

The combination of yardstick competition and the before and after approach yields an often referred to advancement, which is called the difference-in-differences method. It offers the possibility of a panel of time series with cross-sectional data, and actually increases both approaches' validity. The aim is to increase the adequateness of prediction regarding the cartel overcharge by considering a double difference building. The price increase on the benchmark market stands for the regular or normal price increase that would have occurred under competitive conditions on the cartelized market, and which is therefore not attributed to the anticompetitive agreements. This approach is useful for twofold corrections, calculating overcharges and assessing causality.[54]

Application Analysis
Yardstick methods are comparatively easy and quickly to implement. The challenge for economists is reduced, assuming that reliable data are available. The transparency of yardstick results is similar to the one of the before and after approach as the underlying assumptions are easy to grasp and graphical illustration is possible. The Court of France used the yardstick approach in order to estimate cartel overcharges in the Lescarcelle-De Memoris and OGF cartel case as well as the German Federal Court of Justice in the paper wholesaler cartel to assess the cartel gain for quantifying the cartelists' fines.

In reality, the difference-in-differences method is rather error-prone as the requirements that need to be fulfilled are demanding. Time series data for both the cartelized market and the benchmark market are needed. It might be impossible to find a yardstick benchmark that is adequate in terms of comparability and not affected by the cartel in any form. Nevertheless, the frequency of use in executed cartel cases shows the importance of this approach, which is mainly due to the approach's simplicity and plausibility. This seems to be a good compromise between sophistication, reliability and feasibility.

3.2.3 Cost-based Approaches

Basic Information
Cost-based approaches are based on financial information of an industry or company and depict bottom-up analyses for identifying the but-for price. By taking relevant cost input factors of the product of emphasis into account and adding a reasonable profit margin (one that would have emerged under competitive conditions on the relevant market), benchmark prices of per unit costs can be derived.[55]

[53] See Inderst et al. (2013a), p. 30.
[54] See Fumagalli et al. (2010), p. 10.
[55] See Friederiszick and Röller (2010), p. 12.

More precisely, one gathers production costs information from accounting data from internal management reports and divides the total production costs by the total units of output. The difference of the detected cartel price per unit and the estimated per unit costs plus price-cost margin thus reflects the cartel overcharge per unit.[56]

Content Analysis

Data requirements are high for this approach and very time-consuming. The aim of this bottom-up method is to build cost functions. For econometrically deriving such kind of cost functions, there is a basic need of cost data. Alternatively production and input demand information can be used or be relevant. This actually depends on the respective business model of the company concerned (self-production, agent, etc.). A clear definition of costs is decisive for a cost-based method's accuracy and validity.

There are several positive facts that must be attributed to cost-based methods. They are quiet simple to implement as for the most part, solely per unit costs and an adequate mark-up reflecting specific market conditions are required. It is already possible to quantify the cartel overcharge with these two elements. Accounting information is inherently collected by companies.

A possible extension of the original approach lies in drawing on price-cost margins directly in contrast to estimating the counterfactual prices and quantities. A margin increase might be an indicator for the damage. Especially for cartels on input markets, it will regularly be the case that cartelists' profits increase and those of the direct purchaser decrease. It can be assumed that the major part of damage caused will result from a transfer of wealth from the purchaser to the infringing company.[57]

These approaches are obviously based on cost information. The main difficulty in this context is to find robust cost estimates, and even more essential accounting costs are not necessarily identical to economic costs. They can indeed differ dramatically. Accountants deduct a share of the initial investment for each year (either as a constant or a decreasing rate), and write the capital off. Economists focus on the actual value that could be achieved on the market of the investment good, and contrast this with the original capital investment. Accounting depreciation is rarely smaller than zero in contrast to an economic one that can readily be negative when assets appreciate in value.[58]

Next to the divergence in cost definitions, there are some further problems with the cost-based approaches. It is assumed that competitive costs and the relevant margins will be constant over the determined time horizon. No changes in market characteristics are taken into account.[59] As already emphasized for the before and after as well as the yardstick methods, the counterfactual price should be one that would emerge under full competition; i.e.

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[56] See Ashurst (2004), p. 19 et seqq.

[57] E.g. CAPM models or LRAIC models can be drawn on to in order to measure a company's profitability. See Inderst et al. (2013a), p. 29.

[58] See Davis and Garcés, (2010). p. 125 et seqq.

[59] See Ashurst (2004), p. 19 et seqq.

even though oligopolistic competition might be more likely and appropriate for the market of concern, the fully competitive price is alleged to be the proper benchmark. In an oligopoly without any collusive agreement, prices may be above the per unit production costs of perfect competition simply due to the nature of this specific market type.[60] Models taking full competition as a basis and considering significant product differentiation or heterogeneous products are not applicable either, these markets are however less prone to cartelization.

Application Analysis

The lack of understanding or replicability concerning these cost measures' results, and the regularly occurring non-comprehensibility for non-economists is a huge disadvantage in practice. Determining a reasonable price-profit margin regularly depicts challenging tasks for economists. Determining this decisive influence factor objectively might be impossible. In trying to do so, a proper understanding of the relevant firm and market is necessary. Simulating market conditions and company data without a collusive agreement may require a high degree of empirical data and the assessment of the specific company's and product-specific margins.[61] These requirements increase these methods' probability of becoming very time consuming and impracticable. Cost-based quantification has been exercised by the Higher Regional Court Düsseldorf within a foreclosure case of municipal works.[62]

But cost-based prices may actually be a good proxy for competitive market prices in sectors in which there is a clear or comparatively constant relationship between prices and costs. That is to say in sectors that exhibit market prices, which are indeed cost-based and do not solely follow the forces of demand and supply. This pricing especially occurs in mass markets. However, in most cases a competitive price equal to costs cannot be assumed to be the appropriate benchmark as no such clear relationship between prices and costs exists. Already in oligopolistic markets, a price equal to average unit is likely not to occur.

Even though cost-based approaches definitively suffer some disadvantages, these methods' importance and practicability should nevertheless not be underestimated. Cost-based approaches can be used in cases, where company data are not available. There are statistical offices that regularly ascertain production data of main input goods. Economists can make use of these in order to gain an idea about the level of the benchmark. Circumstances in

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[60] See Dijk and Verboven (2008), p. 2338 et seqq.

[61] See Friederiszick and Röller (2010), p. 12.

[62] For further information regarding this case, see: http://www.energieverbraucher.de/files_db/1310984811_2652__12.pdf (accessed: August 2013).

which there is a (huge) lack of company data emerge more often for economists than outsiders might think. Nevertheless, to estimate a specific company's margin can be an approximation only and can only come close to reality by taking the whole market and the form of competition into account; thus also the margins of rivals.

3.2.4 Price Prediction

Basic Information

A more elaborated approach than and an advancement of the before and after or yardstick methods is the one of price prediction. It is the first quantification approach introduced within this paper that is not limited to a perfectly competitive market for the price benchmark but includes oligopolistic behavior for the relevant market players within the non-cooperative comparative market by using direct information concerning the relevant market and including it into structural modeling.

Price prediction is based on regression analysis and thus depicts an ideal statistically robust approach to calculate the counterfactual. Drawing on regression-based methods allows for correcting for various influence factors (by taking them as independent variables into the regression) without any constraint. Pricing influence factors, such as demand changes, supply side coefficients or global prices for input goods and indexes for global economic development can be taken into account in order to adequately calculate the but-for price. The statistic approach thereby allows for estimating in a systematic way.

Basically, there are two main econometric specification models that are used within the anticompetitive context:

1. Dummy variable model: Taking the price as the dependent variable that should be explained, this model considers demand side and supply side factors as the pivotal coefficients that influence the price; the independent variables. A dummy variable is considered moreover. This dummy is a binary variable that can only take on the value 0 in times before or after the cartel period, or 1 during the cartel. The dummy thus accounts for the period of present collusive agreements. If the dummy variable is positive and statistically significant, it determines the average cartel overcharge.[63] The dummy variable is thus supposed to capture the unexplained price increases that occurred during the cartel period. This kind of econometric specification assigns an average amount of the cartel overcharge to all years of the cartel. This restriction indeed shows one of the limitations of this approach.[64]
2. Residual model: This multivariate approach estimates the overcharge by forecasting the price that would have emerged during the determined cartel period without collusion. This forecast is based on pre- and post-cartel data, and on deriving effects of cost and demand shifters on the price. So, the estimated coefficients and the real world values of the independent variables during the alleged cartel period are used for quantifying the but-for price. The overcharge is eventually determined by the difference of actual cartel

[63] See Veljanovski (2007), p. 15.
[64] See Davis and Garcés (2010), p. 357.

prices and the counterfactual, taken the quantity sold into account.[65] The distinction or advancement to the above described before and after and yardstick approaches lies in the fact that a multivariate regression forecast allows to correct for changes in market characteristics, such as shifts in demand and supply. Nevertheless, it is still assumed that the structural relationships within the relevant market remain constant over time.[66]

If the dummy variable approach allows covariates to differ over time and if quantities are the same or regressions are quantity-weighted within the forecast approach, these two price prediction methods' results will even be numerically equivalent.[67]

Content Analysis
Price prediction used for cartel damage quantification requires a very large data base. Provided that the various case data needed are available, it is possible to consider various market influence factors in contrast to most of the comparative approaches. Econometric approaches are the ones that are able to adequately calibrate a probable "real world".

On the downside, the potentially large amount of market influence factors taken into account might also pose significant challenges. For different overcharges each year or changing market characteristics, more elaborated regressions should be performed, their results should be compared with the initial ones from the dummy regression, and the robustness of the latter should be proven. Market players' possibly changing conducts within the determined time horizon are by no means taken into account.

Economists have to be very careful when assessing the adequateness of independent variables. Even very robust results are not necessarily meaningful for the relevant market. It is important not to include irrelevant independent explanation variables to the regression, and particularly misdirecting ones in case that these variables are correlated with the dummy variable. There are some common problems that might arise in multivariate regressions, such as misspecification, endogeneity, multicollinearity, and measurement errors.[68] In order to overcome the obstacle of nonstationarity in the data, which indeed may lead to erroneous results, such as that the variables' relation to each other might only be due to correlation with an omitted variable, an error correction model can be implemented. This model might also correct for short-term dynamics.[69]

Application Analysis
Econometric models for price prediction enjoy great popularity in antitrust procedures. For adequate parameterization, extensive knowledge of the relevant market and its institutions as well as facts of the case of interest is indispensable. Tests of robustness should always be performed after having conducted small changes in specifications. However, no econometric analysis will ever be completely robust and free of potential misspecification. This fact makes these approaches particularly vulnerable towards courts, judges and regulation institutions.

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[65] See Veljanovski (2007), p. 15.
[66] See Davis and Garcés (2010), p. 357 et seqq.
[67] See McCrary and Rubinfeld (2012).
[68] For detailed information regarding these problems, see e.g. Davis and Garcés (2010), p. 81 et seqq.
[69] For further information regarding the error correction model, see e.g. Nieberding (2006), p. 375 et seqq.

They might also have large difficulties to interpret regression results, assess the specifications, and understand the application of the specific techniques. Economists need to be very educated with this kind of econometric model-building and have to prepare very good documentations for increasing this approach's replicability. The dummy variable approach is particularly important in but-for estimations. The residual model is mainly used as a forecast model, which is only based on pre-cartel data and not on post-cartel ones.

The ability of price prediction to accurately assess the cartel induced price increase is highly dependent on the analysis' ability to separate between the cartel effect on price developments and influence factors that are completely unaffected by the anticompetitive agreements. Given that a lot of data is available, and economists are very well educated and acquainted with the econometric challenges, price-prediction has the possibility to model the counterfactual world accurately, which is especially due to possible corrections in market changes and oligopolistic market forms.

3.2.5 Simulation Approaches

Basic Information

Simulation approaches have been typically applied in merger simulation procedures[70] and have only more recently been implemented in cartel damage calculations. These economic models aim at calculating the relevant market data of costs, prices, quantities, and profits with and without collusive agreements within different time horizons (maximum before, during, and after the cartel). They are based on industrial organization theory.

An economic equilibrium model is designed that determines the particular market conditions (such as demand, elasticities, costs, marginal costs, prices, and quantities) for the cartelized market in question and taking oligopolistic behavior of market players as a presumption. By feeding data (without relying on cost data of the alleged companies) regarding decisive parameters, such as price and cost elasticites as well as market shares, into the model, structural information of particular market outcomes result. After having specified the relevant market and company designs, a market simulation tool can calculate but-for price simulations, e.g. how would the counterfactual have changed in case the cartel's duration would have been longer/shorter. The application of simulation tools thus offers the possibility to calculate cartel margins and non-cooperative ones without the need to mainly rely on cost data (delivered by accused firms).

Content Analysis

Given that relevant market and company specific data are indeed available and reliable; various empirical or econometrical techniques can be implemented into simulation methods. All individual parameters determining the simulation tool can be adjusted in a way so that replication of "real world" data can be achieved as approximative as possible (so-called calibration).[71] The decision needs to be made whether Bertrand or Cournot competition should

[70] See e.g. Budzinski and Ruhmer (2010).
[71] See Friederiszick and Röller (2010), p. 11 et seq.

be assumed, in advance of running the simulation tool. Price competition following the Bertrand model is typically alleged for the market players' behavior and thus for the resulting simulated prices, both in pre- and post-merger periods.[72] Taking the particular market circumstances and participating companies behavior into account should be decisive for this decision.

Nevertheless, there are also some intrinsic challenges in market simulation approaches. Specifying oligopolistic behavior for the simulation tools is an obstacle, and profound market understanding is a pivotal prerequisite for that. This is one difficulty often referred to in the scientific literature. Some main market characteristics can facilitate implicit collusion; high barriers to entry, high market concentration, homogenous products, and numerous dispersed purchasers are pivotal in this context.[73] An oligopolistic structure of an industry can thus tend to lead to implicit coordination of prices, resulting in higher prices than the long run competitive price, even without an explicit anticompetitive agreement.[74] Market simulation is still based on economists' assumptions on how the market works and especially on how it would have developed without the anticompetitive infringement.

Counterfactuals can also be derived from accounting cost data plus calculated competitive margins, when combining the simulation with the cost-based approaches.[75] Market simulations in combination with cost-based approaches are particularly useful under specific circumstances, as they additionally encompass firm inherent information and alleviate the pitfalls of cost-based prices by providing a market mechanism that determines prices.

Application Analysis

The implementation of simulation methods is accepted to be useful in merger analysis. Simulation methods focus on a particular market form and do not necessarily take a competitive benchmark for granted. A great advantage of these approaches lies in their transparency. The person trying to comprehend the damage calculation results can do so very easily, as one has only to take a look at the underlying economic assumptions. These as well as further assumed market parameters that are crucial for the outcome are always transparently outlined and easily understandable.

Simulation approaches are regularly very time-consuming, as extensive data are required in order to achieve robustness in estimation results, and these are one hundred per cent based on assumptions. The calculation results may be very sensitive to the underlying assumptions and simulation tool programming decisions. Thus the economic model on how competition takes place between market participants and how they react to competitors' business decisions can only be based on parameterization decisions of economists. But indeed, this approach is comparatively straightforward to a professional economist, even though sounding complex.

Simulation is the most sophisticated method of the cartel damage calculation methods. It is based on a model that specifies the whole industry. Simulation is most certainly not the most

[72] See Epstein and Rubinfeld (2001), p. 886.
[73] For further details regarding factors that facilitate collusion, see e.g. Motta (2004), p. 142 et seqq.
[74] See e.g. Connor (2001).
[75] See Dijk and Verboven (2008), p. 2336 et seqq.

flexible method especially in terms of the structural form of data, and economists should also be very careful in making assumptions. But the specification of an economic equilibrium model that directly takes demand and cost conditions as well as the option of oligopolistic competition conditions into account is the most sophisticated of all quantification. But caution is needed, especially because the method can be very sensitive to assumptions regarding oligopolistic behavior.

3.3 Accuracy vs. practicability

The previous sections discussed the most established methods in order to quantify the true value of damage a cartel has evoked. When economists and experts become acquainted with the respective cartel case and have to make a decision regarding the appropriate quantification instrument, they always face a trade-off between accuracy and practicability (next to some other challenges and facts that reduce the range of adequate methods, such as lack of data, etc.).[76]

As a rule, the first and overall objective in damage quantification is to calculate the cartel induced price increase as accurately and correctly as possible. Unbiased results and precise quantification of the damage have to result, which should be verifiable and present correct estimates. The more economic assumptions are included within the calculation, the more precise the damage estimation especially with regards to changing sectors. Data accessibility and correctness have a huge influence on how transparent and verifiable quantification can be. The more documentation is provided, the higher the degree of replication by a second expert. Reconsidering the aforementioned analysis of damage estimation methods, market simulation is the quantification method that bears the possibility to yield the highest degree of accuracy, given that profound market knowledge is achievable and decisive and large data requirements are satisfiable. Other than that, price prediction (after overcoming statistical obstacles and given that data requirements are fulfilled) and afterwards the cost-based approach (even though assuming perfect competition) deliver the highest accuracy of counterfactual prediction.

All these accuracy factors influence the correctness of damage quantification, but also increase the impracticability of the very same thing and thus decrease the practicability of damage quantification. Estimation processes should proceed within a reasonable time frame and under the principle of proportionality. The resources must be proportional and judicious on both, companies' and economists' sides. The company's accountants are obliged to make data available for the estimations and the data correctness depends (to some degree) on their assembly. Economists are charged with the troublesome tasks of data cleaning. Practicability can best be satisfied with difference quantification methods. Before and after as well as yardstick approaches demand very few data and are quickly executed. The difference-in-differences method does not diminish the degree of practicability much by simultaneously delivering more sophisticated quantification results.

The scope of the trade-off between accuracy and practicability is always case-dependent and highly influenced by data availability. The more disaggregated data are available for the experts' estimations, the higher the accuracy. This is more often the case, when data are provided by the relevant parties and not extracted from public sources[77], even though publicly available data are more objective and by no means manipulated. The number of data acces-

[76] Friederiszick and Röller (2010) actually examined this trade-off against the background of court proceedings, but, from the author's point of view, it can one-to-one be applied to private damage calculation.

[77] Such as statistical offices.

sible determines the number of variables included and the methods applied. There is a negative relationship between the quantities of variables relative to data observations. The less observable data and the more variables included, the lower the accuracy of estimation.

Judges and lawyers are most certainly not always fully able to comprehend economists' damage estimations. This is why experts are obliged to explain the logic and plausibility of methods used, which might also strengthen the trade-off between accuracy and practicability. The order of the damage quantification methods presented in the section above might actually represent increasing accuracy but decreasing practicability, when applying them. Summing up, one should always weigh in which direction damage quantification points. Estimating the damage as exactly as possible is not the superior aim in every case but rather to gain an idea about the damage size as a start.

4. Conclusion

Cartels, no matter if price/quota ones or market sharing agreements, have in numerous cases been politically intended or induced in the medium past and thus did not always stand for anticompetitive infringements. Nowadays, cartels generally are an anticompetitive infringement. After having detected a cartel, by means of special detection mechanisms or whistle blowers, competition authorities impose fines on the cartelized companies.

The quantification of damages within antitrust litigations involves some significant conceptual and empirical challenges. The damage estimates regularly differ enormously from fines imposed by competition authorities as the consequence of the anticompetitive infringement.

A fundamental prerequisite for being able to quantify any cartel damage at all is a profound market understanding. First of all, economists and experts have to get an idea of the cartelized good, the collusive companies, their interactions, as well as the cartel's organizational structure. Figuring out crucial market characteristics, such as supply, demand, elasticities, capacities, prices, etc., is decisive for all further actions. The implementation of each quantification method solely rests on assumptions that are confirmed in practice to the same extent as refuted.

The order of the list of approaches for quantifying damage calculation within this paper reflects the increasing degree of analysis profundity, aspiration level and thus robustness of the estimated counterfactual. The application of each existing quantification method depends on the availability of information, on the one hand, and the envisaged precision of the results, on the other hand. The before and after method, the yardstick and difference-in-differences methods are comparatively modest and yield appropriate quantification measures, but no market changes are considered. Cost based quantification methods entail the distinction between economic and accounting costs, imply a static view and underlying perfect competition, but they generate thoroughly adequate results in cases, where only very few data are available. Price prediction stands out due to its non-static view and the possibility of taking oligopolistic behavior into account. Nevertheless, the same cartel overcharge is assumed for every year under consideration, and misspecifications are possible that could decisively influence the estimation results. Damage quantification based on market simulations has the possibility to come closest to real-world competitive market outcomes, as these

methods do not rely on cost data provided and are very transparent for outsiders, but they imply the largest challenges for economists with regard to market comprehension requirements at the same time.

Estimating cartel overcharges will thus get more and more complex, if dynamic effects are taken into account. A decision between accuracy of quantification results and practicability of implementation needs to be made beforehand. Defining the exact cartel period, as the fundamental prerequisite for damage calculation, might already present an insurmountable obstacle. Price patterns might not be that obvious as e.g. some cartels do need some time to form, or episodes of cheating occur that disturb the price pattern, or temporary reversion to competitive prices occur. The closer the quantification of the actual damage gets to reality (drawing on different market types, such as oligopolistic ones, or types of competition, Bertrand vs. Cournot), the more complex this task gets.

Summing up, there are various cartel damage estimation methods, which all have their advantages and disadvantages concerning the degree of difficulty, data requirements, adequacy, practicability, and replicability. When making use of one of these methods, meeting the legal standards of proof as well as portraying the counterfactual as realistically as possible has priority, with a given level of information and database. This fact influences the adequacy of each quantification method case by case. Each economist is obliged to reliably substantiate the underlying assumptions within the implementation of the various quantification methods. Future research is well advised to shed some light on indirect purchasers' damage, the use of other monetary indexes in case no price data are available and further approaches of cartel detection or markers.

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